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| 09/583,386 | 05/30/2000 | L. Richard Carley | 000265 | 1365 |

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| EXAMINER |
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KIELIN, ERIK J

| ART UNIT | PAPER NUMBER |
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| 2813 | |

DATE MAILED: 04/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|-------------------------------|------------------------------------|--|
| Office Action Summary | Application No. 09/583,386 | Applicant(s) CARLEY, L. RICHARD | |
| | Examiner Erik Kielin | Art Unit 2813 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
 - If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
 - If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
 - Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 13 January 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3,21,22 and 26-33 is/are pending in the application.
- 4a) Of the above claim(s) 27-33 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3,21,22 and 26 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 13 January 2004 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 3, 21, 22, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art, US 5,493,177 (**Muller et al.**) in view of US 6,441,451 B1 (**Ikeda et al.**).

Regarding claim 1, **Muller** discloses a method of fabricating a microstructure in a sealed cavity comprising,

providing a substrate **38** having a substantially planar support surface (Figs. 8A-1, 8A-2);

depositing a first layer of sacrificial material **176**, **177** over said planar support surface (Figs. 8B-1, 8B-2, 8C-1, 8C-2);

depositing an etchable layer of structural material **180** over said first layer of sacrificial material **176, 177** (Figs. 8D-1, 8D-2);

forming a microstructure **24, 28, 116** on said support surface by etching said layer of structural material, said microstructure contacting said substrate at an anchor point (Figs. 8E-1, 8E-2);

depositing a second layer of sacrificial material **184** over said microstructure **24, 28, 116** (Figs. 8G-1, 8G-2);

depositing a cap **186** over said second layer of sacrificial material **184**, said cap **40** layer extending from points on said support surface, whereby said cap layer and said support surface define a capsule about and interior region containing said microstructure and said first and second sacrificial layers (Figs. 8H-1, 8H-2);

forming one or more holes **32, 34** (called "ETCHING CHANNEL") in said cap layer **186**, said holes being restricted to an area of said sealed cavity not directly above said microstructure (Fig. 8I-2);

introducing an etchant into said interior region through said one or more holes **32, 34**, wherein said sacrificial material **184** is chosen to have a high etch rate differential with respect to said structural material, so that said etchant removes said first and second sacrificial layers **176, 177, 184** while leaving said microstructure **24, 28, 116** and said substrate **38** substantially intact, thereby releasing said microstructure **24, 28, 116** as a **movable structure (col. 6, lines 1-54)** secured at said anchor point to said substrate (Figs. 8J-1, 8J-2); and

sealing said one or more holes **32, 34** in said cap layer with a seal layer **190**, thereby forming a sealed cavity that encapsulates said movable microstructure, said sealed cavity being defined by said seal layer **190** and said planar support surface **178** (Figs. 8K-1, 8K-2).

Muller does not teach using dry plasma to remove the sacrificial material.

Ikeda teaches the benefits of using dry plasma etching to remove a sacrificial material 140 through an etching channel 90 to prevent breakage of the microstructure due to surface tension created by liquid etchants, such as the liquid etchant used in **Muller**. (See **Ikeda**, col. 7, lines 12-24, lines 30-35, and especially lines 56-61 and col. 8, lines 58-59; Figs. 1(a)-1(h), Figs. 4(a)-4(h).)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use dry plasma to etch the sacrificial material of **Muller**, to prevent breakage of the microstructure, as taught by **Ikeda** (col. 7, lines 56-61).

Regarding claim 3, **Muller** discloses that the substrate is silicon and has a layer of silicon nitride 178 deposited thereon (Figs. 8A-1, 8A-2).

Regarding claim 21, **Muller** discloses and **Ikeda** teaches that the etchant used to remove the sacrificial layer is specifically selected to have a high etch rate with respect to the sacrificial material and the substrate and cap layers in order to remove only the sacrificial layer, as shown in the Figs. of both **Muller** and **Ikeda**. Formation of microstructures could not occur in the absence of such etch selectivity.

Regarding claim 22, **Muller** discloses and **Ikeda** teaches that the structural material is resistant to the etchant.

Regarding claim 26, **Muller** discloses that the holes are etched into said cap layer so as to establish communication with said first and second layers of sacrificial material. (Fig. 8I-2).

4. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Muller** in view of **Ikeda** as applied to claim 1 above, and further in view of US 5,573,679 (**Mitchell et al.**).

The prior art of **Muller** in view of **Ikeda**, as explained above, discloses each of the claimed features except for teaching that the etchant is introduced by a barrel etcher. However, it has been held that to be entitled to weight in method claims, the recited structure limitations therein must affect the method in a manipulative sense, and not amount to the mere claiming of a use of a particular structure. Ex parte Pfeiffer, 1962, C.D. 408 (1961). In the instant case, it does not matter how the etchant is introduced so long as it is a “non-liquid” to meet the criteria established by Applicant to meet the inventive value of eliminating a liquid etchant.

If it is thought however that the barrel etcher has patentable weight, then this may be a difference. But **Mitchell** teaches a method of removing sacrificial material **24** through holes **34** (Fig. 2D) using a “fluorine-containing” species introduced by a barrel etcher (called “barrel reactor” therein; col. 4, lines 1-13).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to introduce the dry plasma etchant of **Ikeda** to remove the sacrificial material of **Muller** using a barrel etcher, because **Ikeda** is silent to the method of introducing the plasma etchant, such that one of ordinary skill would be motivated to seek out an apparatus for carrying out the etching, such as the one in **Mitchell** since the processes are similar for introducing fluorine-containing etchants which are “non-liquid” into holes to isotropically remove sacrificial material. Furthermore, Applicant has not indicated that the apparatus by which the “non-liquid etchant” is introduced is somehow critical or manipulative of the method.

5. Claims 1, 3, 21, 22, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,798,283 (**Montegue et al.**) in view of and **Ikeda**.

Regarding claim 1, **Montegue** discloses a method of fabricating a microstructure in a sealed cavity comprising,

providing a substrate **14** having a substantially planar support surface (Figs. 2, 3);

depositing a first layer of sacrificial material **30** over said planar support surface (Figs. 4);

depositing an etchable layer of structural material **26** over said first layer of sacrificial material **30** (Figs. 4);

forming a microstructure **26** on said support surface by etching said layer of structural material composed of a structural material **18** on said substrate, said microstructure being secured to said substrate by a first layer of sacrificial material **48** (Fig. 4);

depositing a second layer of sacrificial material **32** over said microstructure **26** (Figs. 5);

forming a cap **34** on said second layer of sacrificial material **32**, said cap **34** layer extending from points on said support surface, whereby said cap layer and said support surface define a capsule about and interior region containing said microstructure **26** and said first and second sacrificial layers **30**, **32** (Figs. 8);

forming one or more holes **48** in said cap layer **34**; (Fig. 11);

introducing an etchant into said interior region through said one or more holes, wherein said sacrificial material is chosen to have a high etch rate differential with respect to said structural material, so that said etchant removes said first and second sacrificial layers while leaving said microstructure and said substrate substantially intact, thereby releasing said microstructure as a **movable structure** (col. 6, lines 13-17) secured at said anchor point to said substrate (Fig. 12); and

sealing said one or more holes in said cap layer **34** with a seal layer **50**, thereby forming a sealed cavity that encapsulates said movable microstructure, said sealed cavity being defined by said seal layer and said planar support surface (Fig. 13).

Montegue does not teach using dry plasma to remove the sacrificial material.

Ikeda teaches the benefits of using dry plasma etching to remove a sacrificial material 140 through an etching channel 90 to prevent breakage of the microstructure due to surface tension created by liquid etchants, such as the liquid etchant used in **Montegue**. (See **Ikeda**, col. 7, lines 12-24, lines 30-35, and especially lines 56-61 and col. 8, lines 58-59; Figs. 1(a)-1(h), Figs. 4(a)-4(h).)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use dry plasma to etch the sacrificial material of **Montegue**, to prevent breakage of the microstructure, as taught by **Ikeda** (col. 7, lines 56-61).

Regarding claim 3, **Montegue** discloses that the substrate **14** is silicon and has a layer of silicon nitride **22** deposited thereon (Figs. 3).

Regarding claim 21, **Montegue** discloses and **Ikeda** teaches that the etchant used to remove the sacrificial layer is specifically selected to have a high etch rate with respect to the sacrificial material and the substrate and cap layers in order to remove only the sacrificial layer, as shown in the figures of both **Montegue** and **Ikeda**. Formation of microstructures could not occur in the absence of such etch selectivity.

Regarding claim 22, **Montegue** discloses and **Ikeda** teaches that the structural material is resistant to the etchant.

Regarding claim 26, **Montegue** discloses that the holes are.

Response to Arguments

6. Applicant's arguments filed 13 January 2004 have been fully considered but they are not persuasive.

Applicant's arguments regarding the Muller, US 5,285,131 patent have been withdrawn. Accordingly, the arguments regarding the absence of a movable structure are moot as Muller US 5,493,177 (also Applicant's admitted prior art) very clearly teaches a movable structure. For example a "resonator." Resonance cannot be created without movement.

Applicant argues that Montegue does not form the sacrificial layer, structural layers, and cap layers on the surface of the **substrate**, but this is very clearly shown in the Montegue Figs. to every extent presently claimed. Simply because a portion of the substrate in Montegue is etched away prior to forming the MEMS structure, does not change the fact that the etch portion is still the upper surface of the substrate. Moreover, note that, as presently claimed, the term "substrate" is **not** used in the claims; rather, the term "support surface" is used. This is not surprising since there is absolutely **no direct contact with the substrate of any feature of the sacrificial materials, the structural material, or the cap materials in the instant specification. (See the instant figures.)** Instead, CMOS circuitry and a protective silicon nitride layer intervene. Accordingly, there exists no support in the specification for direct contact between any of the layers and the substrate. Even though this is not presently claimed, it would only invite a 35 USC 112(1), new matter rejection.

Accordingly, the arguments are not persuasive.

Allowable Subject Matter

7. Claim 4 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

8. The following is a statement of reasons for the indication of allowable subject matter:

The reference of Yao (US 5,578,976) teaches a method of forming a MEMS comprising providing a substrate **12**, sacrificial layers of photoresist **30, 38** (called “polyimide” in **Yao**; Figs 5A-6E) which secure the MEMS to the substrate until etched away, and structural material of aluminum **22, 24**. **Yao** also discloses that it is especially beneficial to use a barrel etcher with an oxygen plasma to remove the sacrificial layers in order to circumvent problems associated with surface tension created by wet etching. (See **Yao**, col. 5, lines 41-65 and especially col. 6, lines 6-13.) Note that the instant specification indicates the objective of the instant invention is to overcome the problems of surface tension by using a “non-liquid etchant” for at least the removal of the last sacrificial layer (specification, p. 3, lines 10-24.)

Yao fails to teach that the microstructure is sealed prior to etching to remove the sacrificial material. Accordingly, it would be at best obvious to try combining the teaching of Yao with either of Muller or Montegue, given the potential uncertainty of the ability of a dry oxygen plasma to remove the photoresist using etching holes in a cap layer, as argued by Applicant in the affidavit filed 23 September 2002 --**specifically along with all of the specifically claimed features.**

Accordingly, the prior art does not teach or suggest, in combination with the other claimed limitations, the use of aluminum as the structural material, photoresist as the sacrificial material and oxygen plasma as the etchant.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Erik Kielin
Primary Examiner
1 April 2004